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UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Electrification Administration
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STANDARD SPECIFICATION
FOR
DEAERATING FEED WATER HEATERS

I. General

A. This specification states the conditions and requirements applicable to the deaerating feed water heaters for REA-financed systems. It applies to _____ ** deaerating feed water heater(s) complete with Quantity auxiliary equipment and accessories described hereinafter, to serve turbine generators of _____ ** kw nameplate rating under the conditions and requirements stated below.

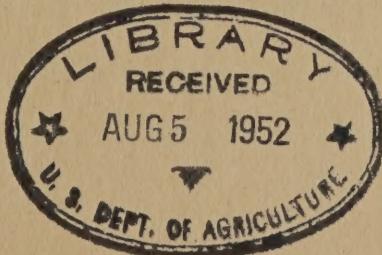
Deaerating feed water heaters and accessory equipment specified herein shall comply with the "Standards of Heat Exchange Institute" unless otherwise stated below, with the applicable provisions of the ASME "Code for Unfired Pressure Vessels" and with the additional requirements of this specification.

B. The following symbols are used throughout the specification:

** to be determined by the project engineer.
øø to be determined by REA for each project.

C. The following will be provided by the purchaser:

1. Structural steel supports, excepting supporting saddles or brackets furnished by the Contractor.
2. Connecting steam, water, drain, vent and overflow piping.
3. Atmospheric relief valve.
4. Float boxes with floats.
5. All instruments and controls except as otherwise stated in this specification.
6. Heat insulation.
7. Anchor bolts
8. Unloading and erecting labor.



II. Application of Deaerating Feed Water Heaters

The deaerating feed water heaters will serve unit-type power stations using ASME-AIEE Preferred Standard Turbine Generators (AIEE Nos. 601, 602, latest revision) of the ratings stated below.

Excerpts from the cited standards

| | | | | |
|--------------------------------------------------------------------------------------------------------------|-------|--------|--------|--------|
| Turbine Generator ratings, | kw: | 15,000 | 20,000 | 30,000 |
| Turbine capability, | Kwt: | 16,500 | 22,000 | 33,000 |
| Throttle pressure, | psig: | 850 | 850 | 850 |
| Throttle temperature, | F: | 900 | 900 | 900 |
| Number of extraction openings, | | 4 | 4 | 5 |
| Saturation temperatures at openings at "turbine-generator rating" with all extraction openings in service, F | 1st | 175 | 175 | 175 |
| | 2nd | 235 | 235 | 235 |
| | 3rd | 285 | 285 | 285 |
| | 4th | 350 | 350 | 350 |
| | 5th | - | - | 410 |
| Exhaust pressure, in. Hg. abs. | | 1.5 | 1.5 | 1.5 |

III Basic Design Conditions (for each heater)

- A. Turbine generator nameplate rating, kw:
15,000 20,000 30,000
- B. Deaerating capacity of heater,
lb/hr: 175,000 235,000 365,000
- C. The deaerating feed water heater will function in station heat cycles which use all the turbine extraction points, as shown on the following Basic Flow diagrams:

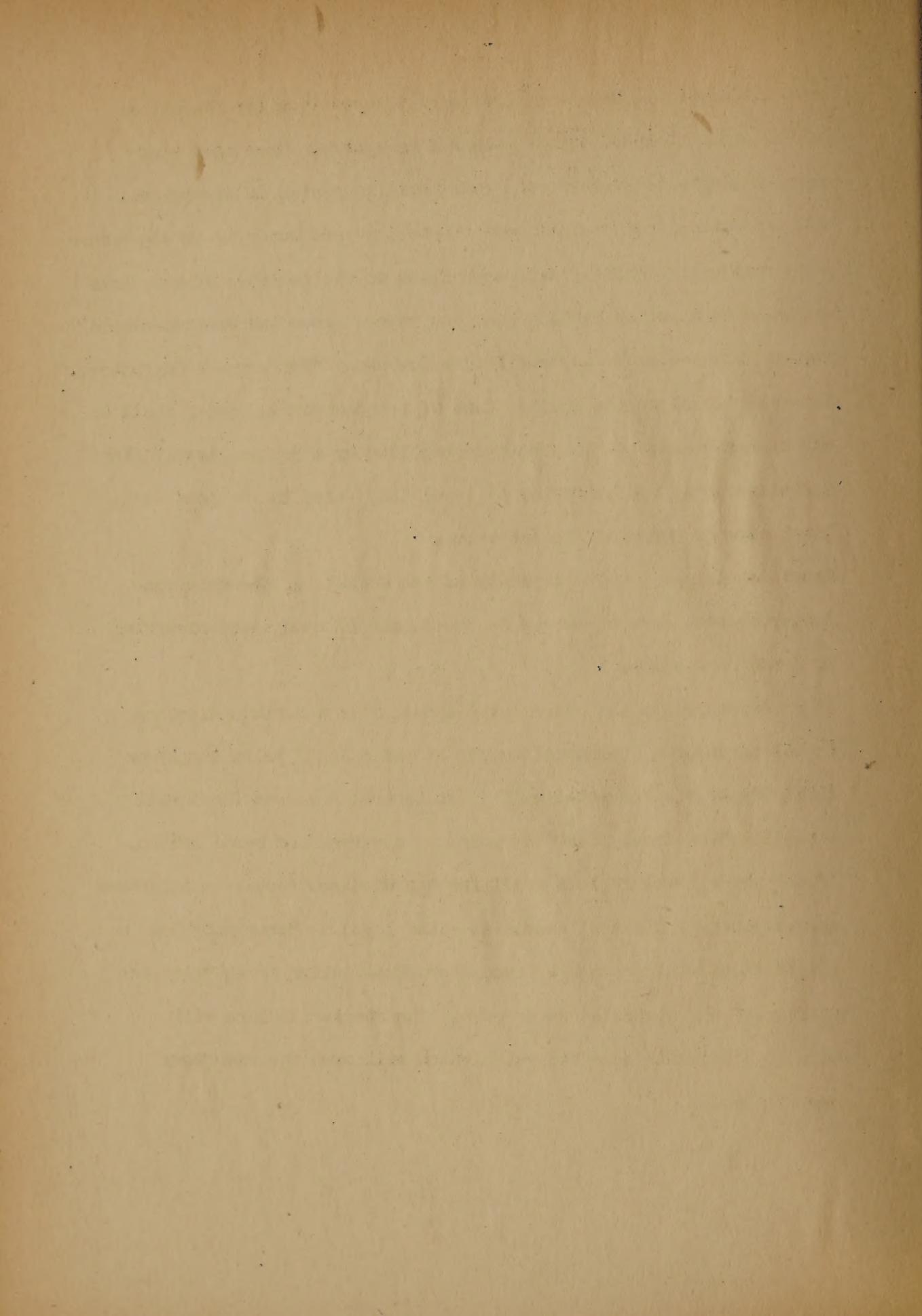
| | | | | |
|----------------------------|-----|--------|--------|--------|
| Turbine Generator ratings, | kw: | 15,000 | 20,000 | 30,000 |
| Basic Flow Diagram | : | S1 | S1 | S2 |
- D. The deaerating feed water heater will at all loads receive steam from the third extraction point of the turbine. (The lowest pressure point being the first point.) Hence the pressure in the heater and its storage tank will follow at all loads the varying pressure of that extraction point, going below atmospheric pressure at partial loads:

a vent line to the main condenser will be used then for evacuation of the gases at those sub-atmospheric pressures. When operating above atmospheric pressure the gases will be vented to atmosphere.

- E. The deaerating heater shall heat the boiler feed water to a temperature corresponding to that of saturated steam at the pressure of the steam entering from the extraction line and remove gases and noncondensable vapors from the water as specified below under "Performance Guarantees."
- F. The water level in the storage tank of the deaerating heater shall be maintained nearly constant being controlled by a "normal-level" float installed on it and operating a regulating valve in the condensate inlet pipe by means of a pilot valve.

Provision is made in the capacity of the hotwell of the main condenser to take care of surges in the supply of condensate occurring in normal operation.

- G. If in an emergency the water level should fall a certain distance (equal to about a 2 minutes' supply at rated load) below the lower limit set by the "normal-level" float control a second float will set off a "low-level alarm" by means of a mercoid or equal switch. If the water level falls a still farther distance (equal to a further approximately 2 minutes' supply at rated load) an "emergency low level" float will actuate a mercoid or equal switch to energize the starter of the distilled water pump. The starter in turn will actuate a solenoid operated valve which will open the emergency supply line.



When the water level has been raised to normal another float will, by means of a mercoid or equal switch, de-energize the starter thus stopping the distilled water pump, and cause the solenoid operated valve to close the emergency supply line.

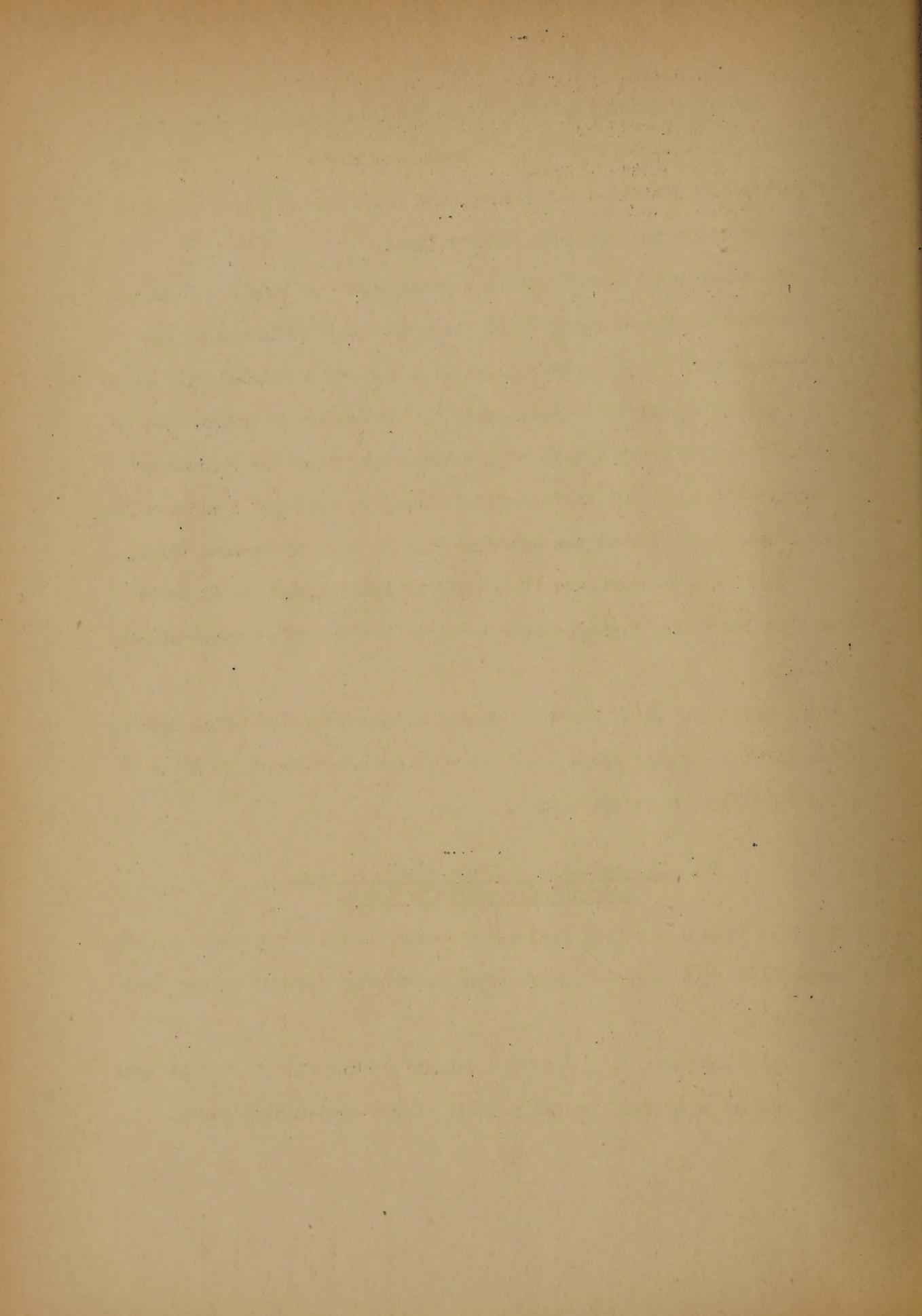
H. If the water level should rise a certain distance (equal to about a 2 minutes' supply at rated load) above the high limit set by the "normal-level" float another float will set off a "high-level" alarm by means of a mercoid or equal switch. If the water should rise to a still higher level (equal to a further approximately 2 minutes' supply at rated load) an "overflow" float, by means of a pilot valve, will open the valve in the overflow line to dump the excess water.
(Note to project engineer: The overflow opening must be at least 40 feet above the highest water level in the distilled water storage tank.)

When sufficient water has been dumped to expose the overflow opening the float described above shall operate the pilot valve to close the valve in the overflow line.

**IV. Equipment to be Furnished with each
Deaerating Feed Water Heater**

A. One tray type deaerating feed water heater, with trays, tray supports, supporting feet and pipe connections to storage tank of heater (see C below).

B. One vent condenser, either of the tubular or the direct contact type with proper provision for the removal of non-condensable gases.



The vent condenser may be either internal or external. It shall be of adequate size to permit deaerating as guaranteed over the entire range of load. If external it shall be provided with suitable means for supporting condenser on the deaerating heater and with vapor and water piping connections to the deaerating heater.

- C. One cylindrical storage tank for heated and deaerated water, with axis horizontal.
- D. Supporting saddles or brackets for storage tank.
- E. Necessary controls as follows:
 1. On vent condenser: vent orifice for normal operation and hand-operated vent valves for starting; automatic control equipment to provide venting to atmosphere when pressure is above 2 to 3 psig, or to main condenser when pressure drops below 2 to 3 psig, including necessary check and control valves and orifices. Valves and control scheme shall conform to the attached diagram S-4.
 2. For separate mounting (make of equipment subject to approval by Purchaser):
One water level recorder for storage tank.
- F. All interconnecting piping including equalizer lines and connections within the equipment.
- G. Instrument connections for the following instruments provided by the purchaser:
 1. Two-pen recording thermometer.
 2. Indicating pressure gauge

3. Two indicating thermometers
4. Water sampler, and
5. Water level recorder furnished with the equipment

The instruments 1, 2 and 3 will be mounted on a panel attached to the heater storage tank.

All necessary steam, water, overflow, drain, vent, and control equipment connections shall be located to suit purchaser's requirements.

H. All necessary manhole and access doors on the deaerating heater and storage tank.

Manhole openings shall be at least 18" in diameter (If elliptical or rectangular, at least 18" on the horizontal and 16" on the vertical axis).

J. Winkler, modified Schwartz-Gurney, test kit, complete with instructions for use, and case, including a sample cooler and all necessary apparatus and solutions for determining oxygen content of water leaving heater.

K. Round gauge glasses of thermal shock resisting glass on storage tank 3/4" diameter and at least 18" long and covering substantially the entire tank height.

V. Design Details

A. General

1. The deaerating heater, vent condenser (if external) and storage tank shall be designed for working pressures from full vacuum to 75 psig. The design and construction shall conform to the ASME "Code for Unfired Pressure Vessels," part UW and to the applicable local and state laws and regulations. Safe working

pressures must not be exceeded by any shock of water flashing in the equipment and the design must be such that water hammer, shock, vibration or objectional noises will not occur.

2. All equipment shall include clips or angles for attaching heat insulation.

B. Deaerating Heater

1. The deaerating heater shall be so designed that not more than .005 cc/liter of dissolved oxygen is present in the effluent at all conditions of load.
2. The shell and heads shall be of welded copper bearing steel per ASTM-A285, grade C.
3. The trays of the deaerating heater shall be of stainless steel, ample in area and arrangement to separate completely the air and noncondensable gases from the incoming water.
4. The tray supports shall be of cast iron, stainless steel or steel.
5. The internal bolting material shall be of non-ferrous material or stainless steel.

C. Vent Condenser

1. Internal Type (if used):

It shall consist of a suitable and adequate means of concentrating vapors by direct contact with the coldest incoming water by provision of greatly increased tray surface or a spray system. All metal parts in contact with the vented vapors shall be of stainless or stainless clad steel. The vent condenser shall vent the non-condensable gases either to the atmosphere or the

condenser (see Schematic Diagram S-4)

2. External Type (if used):

It shall be of the straight tube design so arranged that water passes through the tubes surrounded by steam. It shall be in accordance with the following:

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| 1. Design pressure | Same as design pressure of the deaerating heater |
| 2. Materials: | |
| a. Shell and heads: | Cast iron |
| b. Tubes : | inhibited copper per ASTM B-111 |
| c. Tube sheets : | Muntz metal or naval brass per ASTM-B171 |
| 3. Physical data: | |
| a. Tubes : | 3/4" O.D. - #18 BWG |
| b. Tube sheets : | 3/4" min. thickness |
| 4. The tubes of the vent condenser shall be readily accessible for inspection, cleaning and removal without disturbing the connecting piping. | |
| 5. The vent condenser shall minimize loss of steam through the vent connection under all the conditions of operation as specified under "Performance Guarantees," by providing at least 2 F subcooling of vented vapors over entire load range. | |

D. Storage Tank

1. The shell and heads shall be of welded copper bearing steel per ASTM-A285 grade C.

2. It shall have the following dimensions and capacity:

For deaerating capacity of, lb/hr: 175,000 235,000 365,000

a. Dimensions:

1. Straight plate length to be approximately twice O.D.
2. Top of overflow opening to be not less than ten (10) inches below top of tank.

b. Capacity, cu. ft.:

| | | | | |
|---------------------------|---|-----|-----|-------|
| 1. At overflow level | : | 580 | 765 | 1,200 |
| 2. At normal level | : | 415 | 545 | 855 |
| 3. At pump starting level | : | 250 | 330 | 515 |
| 4. At high level alarm | : | 495 | 655 | 1,025 |
| 5. At low level alarm | : | 330 | 435 | 680 |

3. The pipe carrying water from the deaerating heater to its storage tank shall empty the water close to the storage tank outlet, which shall be at the bottom of the tank, and the tank outlet pipe shall extend 3" into the tank and be provided with a screen or hood, to prevent foreign material from entering the boiler feed pump.

E. Piping and Pipe connections:

1. The following connections shall be included:

For deaerating heater capacities of,

lb/hr: 175,000 235,000 365,000

| | | | | |
|---------------------------------------------------------------|-----|----------------------------------------------------------|----|----|
| a. Water inlet to deaerator | in: | 6 | 6 | 8 |
| b. Steam inlet to deaerator | in: | 8 | 8 | 10 |
| c. Water outlet from storage tank (to boiler feed pump) | in: | 8 | 10 | 12 |
| d. Drain from storage tank | in: | -----2 x 2 $\frac{1}{2}$ ----- | | |
| e. Overflow from storage tank | in: | 6 | 6 | 8 |
| f. Vapor inlet from evaporator | in: | -----Included in b----- | | |
| g. Evaporator tube drain | in: | 2 $\frac{1}{2}$ | 3 | 4 |
| h. High pressure heater drips | in: | 4 | 4 | 6 |
| i. Boiler feed pump recircula- tion to storage tank | in: | 2 | 2 | 3 |
| j. Relief valve | | As required by "Standards of Heat Exchange Institute" | | |

2. All flanged connections shall be made in accordance with the A.S.A. standard for the maximum pressure expected.
3. All pipe connections on the equipment 2 in. and under shall be screwed and all pipe connections $2\frac{1}{2}$ in. and over shall be flanged.
4. All pipe flanges shall be 150 lb. standard steel.
5. All flanges shall be faced and drilled in accordance with the rules of the American Standards Association for 150 psi, except that flat faces shall be furnished.
6. All pipe 2 in. and under, shall be extra strong steel, and all pipe $2\frac{1}{2}$ in. and over shall be standard weight, seamless or lap welded steel.

F. Fittings and Valves:

1. All screwed pipe fittings shall have American Standard pipe threads per A.S.A. - B2.1.
2. All fittings 2 inches and under, shall be standard weight, screwed 300 lb. malleable iron and all fittings $2\frac{1}{2}$ inches and over shall be standard weight steel welding fittings.
3. All valves 2 inches and under, shall be 200 psi standard bronze globe valves, union bonnet, rising stem and screwed ends, with renewable hard metal seats and discs.
4. All valves $2\frac{1}{2}$ inches and over shall be standard weight, flanged cast iron gate valves with bronze trim, bolted bonnet, outside screw and yoke and flanged ends, except for such special valves as may be required.

VI. Tests

The deaerating heater, vent condenser and storage tank shall be tested after fabrication, in accordance with the applicable provisions of ASME "Code for Unfired Pressure Vessels," and shall be so stamped with the ASME symbol (or with the National Board Stamp if required by state and local regulations).

VII. Painting and Protection

A. The interior surfaces of shells and heads of the deaerating heater and storage tank shall be thoroughly cleaned of all mill scale by grit blasting and oil and grease shall be removed from the interior surfaces with a nonflammable, and only mildly toxic chlorinated hydrocarbon such as methyl-chloroform. The latter must not be used on aluminum and above 120F, and its concentration in air must not exceed 300 ppm supplemented by forced ventilation. All openings shall be closed for shipment. The purchaser will apply two coats of Apexior No. 1 or equal to the interior surfaces of the deaerating heater and storage tank after receipt on the site.

The exterior surfaces shall be shop painted with one coat of red lead and oil paint.

B. All material shall be carefully boxed, crated or otherwise protected for shipment. Flanges shall be protected and studs and exposed finished surfaces shall be thoroughly greased before shipment.

VIII. Physical Data Required with Bid

A. Deaerating Heater

| | |
|---------------------------------------|------------------------|
| 1. Heater O.D. and length over heads, | ft. in.: _____ X _____ |
| 2. Metal thickness, shell and heads, | in.: _____, _____ |
| 3. Size of relief valve opening, | in.: _____ |

B. Trays

1. Size, in.: X
2. Number, _____
3. Type of stainless steel, _____

C. Storage Tank

1. O.D., and length over heads, ft. in.: X
2. Metal thickness, shell and heads, in.: _____

D. Vent Condenser

1. Internal Type

- a. Type (tray or Spray) : :
- b. Material of baffle : _____
- c. Material of inlet spray pipe : _____
- d. Size of vent to atmosphere in.: _____
- e. Pressure loss of water through vent condenser at ** lb/hr Ft. of water: _____

2. External Type

- a. Condenser approx. O.D., and length over water boxes ft. in.: X
- b. Tubes, approx. number and effective length ft. in.: _____, _____
- c. Tubes, surface, sq. ft.: _____
- d. Tube fastening, inlet, : _____
- e. Tube fastening, outlet, : _____
- f. Size of vent to atmosphere in.: _____
- g. Pressure loss of water through vent condenser at ** lb/hr Ft. of water: _____

E. Combined Equipment

1. Over-all height of heater tank and vent condenser, ft. in.: _____
2. Weight including vent condenser and all piping: Empty, lb.: _____
Operating, lb.: _____
Flooded, lb.: _____

F. Gauge Glasses

1. Make _____
2. No. on storage tank: _____

G. Miscellaneous Data

1. Dimension sketches for deaerating feed water heater, vent condenser and storage tank including location and size of connections.
2. Cross section sketches for deaerator and vent condenser.

IX. Performance Guarantees Required with Bid

The bidder guarantees, on the basis of the following figures given to him, that the performance of the deaerating feed water heater will be as stated below by him.

**A. Figures Given to Bidder

| | | | | | |
|-----------------------------------------|-----------------|-------|-------|-------|-------|
| 1. Turbine generator output | % of rating: | 25 | 50 | 100 | 114.4 |
| 2. Turbine generator output | kw: | _____ | _____ | _____ | _____ |
| 3. Condensate to deaerator | lb/hr: | _____ | _____ | _____ | _____ |
| 4. Condensate to deaerator | Temperature F.: | _____ | _____ | _____ | _____ |
| 5. H.P. heater drips to deaerator | lb/hr: | _____ | _____ | _____ | _____ |
| 6. Enthalpy of H.P. drips | BTU/lb: | _____ | _____ | _____ | _____ |
| 7. Steam pressure at deaerator inlet | psia: | _____ | _____ | _____ | _____ |
| 8. Enthalpy of Steam | BTU/lb: | _____ | _____ | _____ | _____ |

B. Guarantees by Bidder

| | | | | | |
|---------------------------------------------------|-----------------|-------|-------|-------|-------|
| 1. Steam condensed | lb/hr: | _____ | _____ | _____ | _____ |
| 2. Heated and deaerated water from deaerator | lb/hr: | _____ | _____ | _____ | _____ |
| 3. Temperature water leaving deaerator | F: | _____ | _____ | _____ | _____ |
| 4. Dissolved oxygen content, heated water-max, | cc per liter**: | 0.005 | 0.005 | 0.005 | 0.005 |

The bidder further guarantees that under the conditions stated in the last column listed above, the residual free carbon dioxide shall not exceed _____ ppm, and a residual content of other dissolved gases consistent with their relative solubility and ionization. The test for free carbon dioxide shall be in accordance with the method outlined in "Determination of Carbon Dioxide in Water" in the May 1944 issue of "Industrial and Engineering Chemistry," analytical edition.

* Measured according to "Method and Procedure for Determination of Dissolved Oxygen" of the "Standards of Heat Exchange Institute."

